

The Status and Distribution of the Persian Squirrel, *Sciurus anomalus* (Mammalia: Rodentia: Sciuridae), in Dibbeen Nature Reserve, Jordan

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Abstract. During the present survey, the presence of the Persian squirrel, *Sciurus anomalus*, was established in Dibbeen Nature Reserve and other localities in Jordan. Its presence was based on direct visual observations and finding remains of consumed pine acorns. Despite intensive trapping effort that totalled 476 trapping nights, all trapping attempts gave negative results. Examination of freshly consumed acorn remains constituted an excellent tool to identify the presence or absence of squirrels across the reserve. Remains of 219 freshly consumed pine acorns, 69 old and 34 very old were recovered from various locations in the reserve. Freshly consumed acorns formed continuous clusters in most of the studied localities. Also, remains of fresh, old and very old acorns were concentrated in pine forested areas, and with less frequency in mixed pine-oak forested regions.

Kurzfassung: Das Vorkommen des Eichhörnchens, *Sciurus anomalus*, im Naturschutzgebiet Dibbeen und an anderen Orten Jordaniens wurde während dieser Studie nachgewiesen. Die Nachweise basieren auf direkten Beobachtungen und Funden konsumierter Reste von Kiefernzapfen. Ungeachtet intensiver Bemühungen, die Tiere mit Fallen zu erbeuten (insgesamt 476 Nächte), waren alle derartigen Anstrengungen erfolglos. Die Untersuchung von Resten frisch konsumierter Kiefernzapfen erwies sich als gut geeignetes Nachweiskriterium, ob Hörnchen im Gebiet anwesend waren oder nicht. Die Reste von 219 frisch konsumierten, 69 alten und 34 sehr alten Kiefernzapfen wurden an verschiedenen Orten des Gebietes aufgefunden. Frisch konsumierte Kiefernzapfen bildeten bei den meisten der untersuchten Fundorte größere Ansammlungen. Die Reste von frischen, alten und sehr alten Kiefernzapfen konzentrierten sich in Kiefernbeständen und weniger häufig in gemischten Kiefern-Eichen-Beständen.

Introduction

The Persian Squirrel, *Sciurus anomalus* GUELLENSTAEDT, 1785, is the only representative of family Sciuridae in the Middle East. The forest covered mountains of Jarash and Ajlun in Jordan are the most southern range of its distribution (AMR, 2000). This species is distributed from Greece through Turkey, Armenia, Georgia, Azerbaijan, Iran, Iraq, Palestine, Jordan, Lebanon and Syria in coniferous and temperate mixed forests (HARRISON & BATES, 1991).

Three subspecies of the Persian Squirrel are recognized; *Sciurus anomalus anomalus* GUELLENSTAEDT, 1785, distributed in the southern former Soviet Union, *Sciurus anomalus pallescens* GRAY, 1867 in northern Iraq, and *Sciurus anomalus syriacus* EHRENBERG, 1829 in Syria, Lebanon, Jordan and Palestine. This is based on the coloration of specimens; where as *Sciurus anomalus syriacus* has dark dorsal pelage and its tail and feet are generally dark in colour, while *S. a. anomalus* has a deep red tail and *S. a. pallescens* has pale back and feet and yellowish brown tail (ELLERMAN, 1948; HARRISON & BATES, 1991).

Very little is known concerning the biology and ecology of the Persian Squirrel within its range of distribution. GAVISH (1993) gave some preliminary field observations on the behaviour and ecology at Mount Hermon. She included brief summaries on some aspects of activity, nest selection and feeding habits.

In the Greek Islands, important studies focused on the threats and population dynamics and structure. MATSINOS & PAPADOPOULOU (2004) indicated that habitat loss and fragmentation are considered to be the most important factors responsible for population decline of the Persian Squirrel. HECHT-MARKOU (1994, 1999) studied the distribution and habitat, and the territorial behaviour of the Persian Squirrel, reporting that the territory is marked by urine and faeces and was renewed several times daily. Other studies gave some accounts on the ecology and distribution of the Persian Squirrel in Turkey (ÖZKAN, 1999) and its morphology and karyology (ÖZKURT *et al.*, 1999).

The main objectives of the Persian squirrel study in Dibbeen nature reserve were to establish its presence/absence and distribution, assess the correlation between its distribution and the different vegetation types, and to identify threats that affect the current population of the Persian Squirrel in the reserve.

Materials and Methods

The Study Area

Dibbeen forest extends over 60 km² of mountainous terrain (North-West coordinates 35° 46' 31" E, 32° 15' 49" N; South-East coordinates 35° 51' 06" E, 32° 12' 35" N), with elevation varying between 570 to 1050 m asl), and a vegetation dominated by pine/oak trees. The reserve represents the core area of this forest and covers an area of 8 km².

Dibbeen Natural Reserve consists of three main stand types, distributed according to altitude. In the lower elevations, Aleppo pine (*Pinus halepensis*) is dominant and there are some pure stands with large native trees, represented by the area of the public park. In the middle elevations, a pine-oak (*Pinus halepensis/Quercus calliprinos*) association is dominant and extends over the majority of the area. In the upper elevations, the oak is the dominant species with small stands of deciduous oak (*Quercus infectoria*) on the uppermost slopes. Other trees present in the forest include arbutus (*Arbutus andrachne*), pistachio (*Pistacia palaestina*) and wild olive (*Olea europaea*). The ground flora is exceptionally rich and includes several orchid species. This is an especially noteworthy feature of the wadis around the reserve's perimeter. The flora of the reserve consists of 249 species in 51 families.

Dibbeen forest hosts 21 reptilian, 75 avian and 18 mammalian species. The core area provides habitats for 17 globally endangered species (6 plant, 8 reptile and 3 birds).

Methodology

Havahart traps (model number 1025, 45.7 cm in length, 12.7 cm in width and height) were used. Several baits were used in an effort to attract squirrels, including peanuts butter and oat, sunflower seeds, cucumber, bread with peanuts butter, and nuts and corn.

Preliminary (opportunistic) trapping

Preliminary trapping began in the period between the May 17, 2005 and June 16 2005, with 26 trapping days using 30 traps daily, with a total of 476 trapping attempts. Visual observations of individuals and recovery of pine cones consumed by squirrel were the main criteria for setting the traps. Also, traps were set at random sites with no previous observations.

Traps were distributed in different manners: either by placing all traps in one area or by placing them in two or three locations. Traps were placed under pine tree, covered with grasses and leaves. Traps were placed either in line transects, or as a loop with no concern to its boundaries.

Due to the diurnal activity of the Persian Squirrel, baiting was carried out immediately before sunset. In secured areas, traps were left for one or two successive nights, and checked daily in the morning and the afternoon.



Figure 1. The Persian Squirrel, *Sciurus anomalus*, as observed on a pine tree in Dibbeen Nature Reserve.

Visual Surveys

Field observations following daily schedule of walking or travelling by car across the reserve were recorded. About 100 hours of field observations were spent to look for squirrels among the trees and on the road. Records were positioned using Global Positioning System “GPS”. Also, data obtained from earlier baseline survey (March–May, 2004) were incorporated.

Consumed pine cones

Due to failure in capturing squirrels by live trapping, we resorted to this method to obtain data on the distribution of the Persian Squirrel in Dibbeen Nature Reserve. This method was adopted during the period that extended from 17–22 June, 2005.

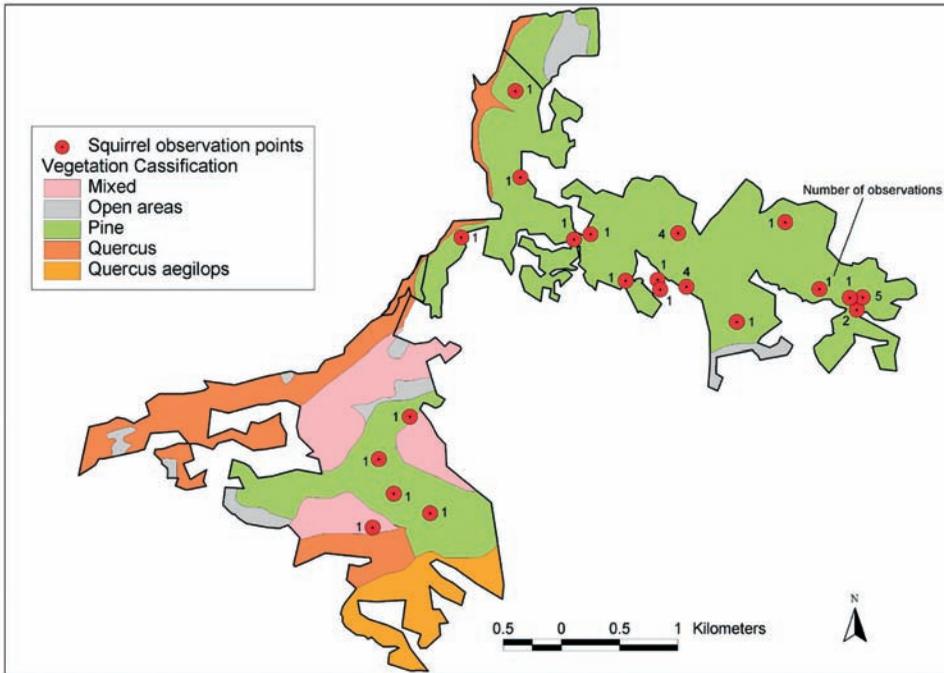
Looking for consumed pine cones was carried out twice per a day, early in the morning (8:30 am) and late in the afternoon (after 4:00 pm) for three to four walking hours. Signs of freshly consumed pine cones were considered as positive indicator for the presence of squirrels. Remains of old and the very old consumed cones were also recorded. All records were positioned using GPS.

Results

During the present survey, the presence of the Persian squirrel, *Sciurus anomalus*, was confirmed in Dibbeen Nature Reserve (Figure 1). The records are based on direct visual observations and finding remains of consumed pine cones.

Visual observations of the Persian Squirrel yielded 32 sighting records during 2004–2005. Map 1 shows locations of observed squirrels based on visual observations. Animals were sighted mainly on pine trees or on the ground during early morning hours, and all day long at a lesser frequencies. Squirrels were observed close to the garbage containers near the rest house searching for food remains. The number of observed individuals ranged from 1-9. Thirty one observations were recorded from exclusively pine forests and only one observation from mixed pine-oak forested locality.

Examination of freshly consumed pine cones remains constituted an excellent tool to identify the presence or absence of squirrels across the reserve. Remains of 219 freshly consumed,



Map 1. Sites where visual observations of squirrels in Dibbeen Nature Reserve.

69 old and 34 very old pine cones were recovered from various locations in the reserve (Figure 2–4). Freshly consumed cones formed continuous clusters in most of the studied localities (Map 2). The number of freshly consumed cones ranged from 4–9 cones around pine trees, with an average of 5. Also, remains of fresh, old and very old cones were concentrated in pine forested areas, and with less frequency in mixed pine-oak forested regions. In some localities, fresh, old and very old cones were observed.

Despite intensive trapping effort that totalled 476 trapping nights, all trapping attempts gave negative results. However, the Broad-toothed Field Mouse, *Apodemus mystacinus*, the Great Tit, *Parus major*, and the Long-eared Hedgehog, *Hemiechinus auritus*) were occasionally trapped.

Squirrels were observed either individually or in groups reaching 9 individuals. The animals exhibited two activity peaks; early morning hours until around 9 am, and another peak two hours before the sunset when they start making calls and noises. When disturbed, animals always escape to pine trees although oak trees are present.

Nesting sites of the Persian Squirrel

Animal was always observed either on the ground looking for food remains, or on top of trees hiding or feeding on green cones that are usually found on the top of trees. However, tree holes (Figures 5 and 6) are possible nesting sites for the squirrel. Food remains that consist of bread and old cones were spotted close to or inside tree holes. Also, nests are located on thick branches with large amount of pine needles at various elevations. In Ajlune Nature Reserve, we located a nesting site with a new born squirrel on a tree.

Perhaps squirrels seek refuge in ground burrows located under large trees. Several burrows contained food remains around the entrance or inside.



Figure 2. Pine acorns showing evidences of squirrel feeding. Freshly consumed acorns were eaten by squirrels at the day of inspection. They are characterized by a white or light inside and green unconsumed part and are tender and fleshy.

Figure 3. Old consumed acorns eaten 2–3 days earlier. They are characterized by brown to dark brown color with sticky and hard stiff cones.

Figure 4. Very old consumed acorns characterized by a dark brown color, with old texture.

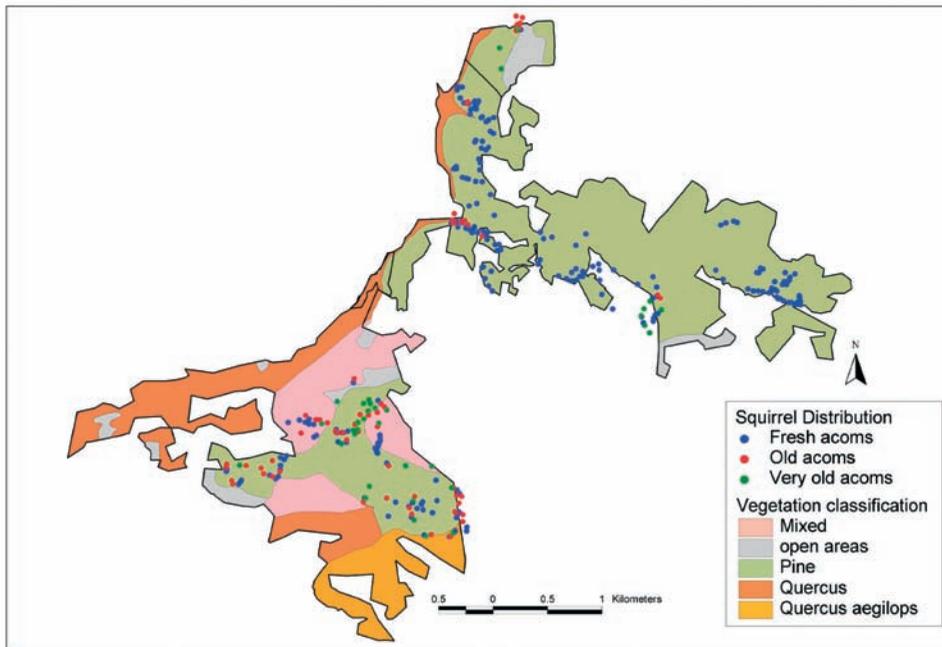
Distribution of the Persian Squirrel in Jordan

Several sites extending apart from Ajlune Nature Reserve and Dibbeen Nature Reserve were investigated for the presence of the Persian Squirrel. Similarly, the presence of the squirrel was based on finding freshly consumed cones within the forests. All the forests are natural with mixed pine and oak trees. We located freshly eaten pine acorn around Ajlune nature Reserve, Raimoon, between Sakeb and Anjara (Map 3).

Despite tedious efforts to find fresh cones or verbal records in Zay natural forests, we could not find substantial evidences for fresh signs. All cones were very old and perhaps were a food source for the squirrel.

Threats affecting the Persian Squirrel

Threats identified during the course of this study include habitat fragmentation within the reserve. This is evident in areas are cultivated with olive and other crops of economic importance which located within the reserve and its boundaries. Fire and habitat disturbance may have an effect on the current population and should be closely monitored and studied in the future. Wood cutting and deforestation are the major threats facing the current population in the reserve.



Map 2. Sites where various forms of consumed acorns were recovered in Dibbeen Nature Reserve.

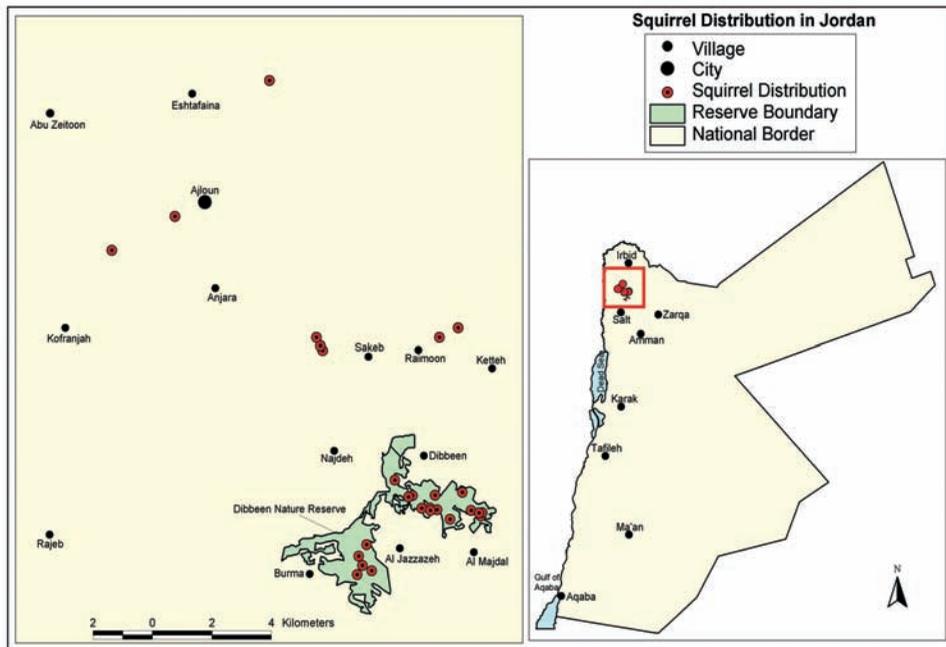
Scarcity of water during summer has a negative impact on the surviving population of this animal. Four animals were found drowned in water tanks situated on the roofs of scattered rest houses within the reserve. It seems that these animals fall inside the tanks while attempting to drink. Water is a limiting factor to the squirrel's distribution and several individuals were seen around the leaking water pipes.

The effect of human impact in the form of vacationing and tourism is nevertheless confusing. It seems that the squirrel population in Dibbeen Nature Reserve became adapted to the presence of people and vehicles that are continuously passing through the different parts of the reserve.

Discussion

The distribution of the Persian Squirrel in Jordan represents its most southern range of distribution (AMR, 2000). Its occurrence in Jordan perhaps represents relict populations which have been separated from the continuous range of distribution that extends from the Caucasus through Anatolia, western Syria to Jordan. The Persian Squirrel has been recorded from several localities in Syria: Mount Hermon and around Damascus (TRISTRAM, 1866), and from Kastel Maaf, Furunlock and Slenfeh (VON LEHMANN, 1965). Furthermore, ILANI & SHALMON (1984) noted its increasing population in the Golan Heights. In Lebanon, this animal seems to be rare (LEWIS *et al.*, 1967). In Palestine, it is common in the upper Galilee (BODENHEIMER, 1935; GAVISH, 1993).

The presence of the Persian squirrel was established visually in Dibbeen Nature Reserve. Although no previous studies reported negative trapping results (GAVISH, 1993; MATSINOS & PAPADOPOULOU, 2004), in the present study we failed to trap this animal despite a total of 476 trapping nights. Perhaps bait shyness may explain our results. The Red Squirrel, *Sciurus vulgaris*, was easily trapped using ground-placed Tomahawk 'squirrel' traps (TRIZIO *et al.*,



Map 3. Distribution of the Persian Squirrel in Jordan.

2005). However, visual sighting and finding freshly consumed acorn remains were sufficient to identify the spatial distribution of the Persian Squirrel in Dibbeen Nature Reserve. The animal was seen scavenging on food remain in garbage dumpsters near the park several times. This behaviour was not reported previously.

The distribution of the Persian Squirrel in Dibbeen Nature Reserve covers almost all habitats with pine trees (Map 1), and covers over a large area of the reserve. Freshly consumed cones are clustered in pine dominated habitats, where mixed old and recent cones were observed. Results obtained based on visual observations are confirmed by finding freshly consumed pine cones within the same locality (Map 1 and 2). Furthermore, relying on freshly consumed pine cones constitute an excellent indicator for the presence/absence of squirrels as suggested by GURNELL *et al.* (2001). Such surveying technique can be employed by rangers and field researchers in squirrel survey.

The current distribution of the Persian Squirrel in Jordan and elsewhere represents the past history of the continuous pine/oak natural forests that used to extend along the eastern Mediterranean. Certainly, forest fragmentation and extensive wood cutting in the Middle East over the past hundreds of years particularly in Jordan, Syria and Lebanon caused severe loss of forested areas extending from north to the south. Such fragmentation certainly formed isolated populations with intrinsic genetic variations. In Lesbos Island, MATSINOS & PAPADOPOULOU (2004) indicated that habitat loss and fragmentation are considered to be the most important factors responsible for population decline of the Persian Squirrel. Their results suggested that special attention has to be paid to the planning of road system networks and to stopping illegal hunting, especially when extinction risks for vulnerable populations are high. Also, landscape management practices that change the degree of habitat fragmentation can considerably affect the genetic structure of existing animal populations. British red squirrels use “stepping stone” patches of habitat to cover significant distances through a fragmented habitat. Planting conifer forest has connected groups of forest fragments in the north of England with those in southern



Figure 5 and 6. Tree holes that may be used as nesting sites.

Scotland. Such “de-fragmentation” of the landscape has resulted in considerable mixing of Scottish and Cumbrian genes in squirrel populations up to 100 kilometres from the site of the new forest. These results have implications for the conservation management of animal and plant species in fragmented landscapes such as those found in Britain (HALE *et al.*, 2001). Further studies should address the genetic variation of the Persian Squirrel population in northern Jordan. Also, more in depth studies should focus on the ecological requirements, home range, and the reproductive cycle of this animal. Quantified studies should focus on the threats affecting the current population of the Persian Squirrel in Dibbeen Nature Reserve and elsewhere in Jordan.

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